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AUTHOR Weimer, Michael; Miller, Asenath A.
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ABSTRACT

The study attempted to minimize nonspecific response strategies which supposedly mask the positive effect of perceptual pretraining on initial discrimination learning within the predifferentiation paradigm. The subjects were 44 first- and second-graders. Experimental-group subjects received rules learning (RL), pretraining, initial discrimination (ID), and reversal shift (RS) phases. Rules learning consisted of a two-choice discrimination using stimuli varying on shape and orientation-of-line, and was designed to teach subjects to associate a specific dimensional value with the correct response. During pretraining, subjects made "same-different" judgments on pairs of stimuli varying on height and brightness. The ID and RS phases again involved a two-choice discrimination with a subset of the stimuli used in pretraining. Three additional groups controlled for the effects of RL, pretraining, and RL plus pretraining. The results showed that subjects given RL learned the ID phase more rapidly than subjects not given RL (p less than .01) Pretraining did not facilitate ID learning. Neither RL, pretraining, nor a combination of RL and pretraining facilitated RS learning. Similarities between the present study and learning-set literature, the failure of perceptual pretraining to facilitate ID learning following RL, and the failure of RL, pretraining, or both to affect RS learning are discussed. (Author/CS)

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THE EFFECTS OF "RULES" LEARNING ON INITIAL DISCRIMINATION LEARNING WITHIN THE PREDIFFERENTIATION PARADIGM

Michael J. Weimer[1] and Asenath A. Miller[2]

Northern Illinois University

The study of children's discimination learning has often been approached from the viewpoint of reinforcement theory or mediation theory. Recently, however, analyses of children's discrimination learning have been made from the viewpoint of psychologists interested in perception. One of the major perceptual approaches has been that of differentiation theory proposed by James and Eleanor Gibson (e.g., Gibson, 1969).

Eleanor Gibson (1969) defines perceptual learning as "an increase in the ability to extract information from the environment, as a result of experience and practice with stimulation coming from it" (p. 3). A major premise resulting from this definition and differentiation theory, as stated by Stevenson (1972), is that "a child is able to discriminate and differentiate an object more accurately after he has had experience in comparing and contrasting this object with others of varying degrees of difference" (p. 261).

PS 007 666

A series of experiments by Thomas and Louise Tighe (1968a, 1968b, 1969) have attempted to verify this premise of differentiation theory. Through their work, Tighe and Tighe have specified the effects of perceptual pretraining experience on subsequent discrimination learning in children, and they have identified some of the important pretraining variables that lead to improvement in discrimination learning.

Tighe and Tighe have used what is known as the "predifferentiation"

paradigm or design. It consists of three phases: a pretraining phase, an initial discrimination phase, and a reversal shift phase. Pretraining involves presenting Ss with a Standard (St) stimulus cylinder and a series of Comparison (Co) stimulus cylinders varying on two dimensions, height and brightness. During this phase, Ss are asked to judge whether each of the Co stimuli are the "same as" or "different from" the St stimulus. Besides requiring Ss to make active "same-different" judgments, Tighe and Tighe have identified other variables that are necessary in order for pretraining to be effective. These variables include representing each stimulus dimension by three or more values, and giving Ss at least eight experiences with each of the Co stimuli. Variables that do not influence the effectiveness of pretraining include the method of presentation of the stimuli (it can be either simultaneous or successive), and information as to correctness of the S's judgments (presence or absence of reinforcement makes no difference).

In the initial discrimination (ID) phase following pretraining, Ss are given a series of simple, two-choice discriminations using the St stimulus cylinders employed in pretraining. The stimulus pairs are always either a tall white vs. a small black cylinder, or a tall black vs. a small white cylinder, with one of the four dimensional values serving as the positive cue associated with reinforcement. When the S has reached a certain response criterion, the reversal shift (RS) phase is immediately implemented without the S's knowledge. To master the RS phase, the S must discontinue his former response strategy and learn to respond consistently to the other value of the same dimension, until the required criterion is met once again.

Given the overall paradigm, differentiation theory would predict that pretraining should improve both subsequent ID and RS learning by emphasizing

the dimensional nature of the stimulus properties. Tighe and Tighe have found that pretraining does facilitate RS learning, but not ID learning. In discussing these results, they hypothesize that nonspecific response strategies operating only during the ID phase, such as position or alternation response tendencies, may be masking the facilitory effect of pretraining on ID learning. In order to test this assumption, Tighe and Tighe have suggested giving some Ss, prior to pretraining, a discrimination phase involving dimensions other than those used in later discriminations. In this way these Ss, having learned the "rules of the game", should be looking for or be sensitive to specific stimulus-value/reward relationships, and respond accordingly during the ID phase following pretraining.

The Present Study

The present study incorporated a rules-learning phase into the predifferentiation design prior to pretraining in order to minimize nonspecific response strategies during the ID phase. The rule involved learning to associate a specific dimensional value (e.g., the TALL stimulus) with the correct response. Tighe and Tighe (1969) have hypothesized that following this rules-learning phase, pretraining should facilitate both ID and RS learning with a new set of stimulus dimensions.

Those Ss in the experimental group received the following tasks: rules learning, pretraining, and the ID and RS phases. The rules-learning phase consisted of a two-choice discrimination task with a single relevant dimension, either shape or orientation-of-line. Pretraining consisted of making nonreinforced "same-different" judgments on eight series of cylinders varying in height and brightness. The ID phase involved a second two-choice discrimination task using a subset of the pretraining stimuli. The relevant

dimension was either height or brightness. For the RS phase the positive cue on the relevant dimension was reversed.

Three control groups were used: one group, controlling for rules learning, received only pretraining, ID and RS; a second group, controlling for pretraining, received only rules learning, ID and RS; a third group, controlling for both rules learning and pretraining, received only the ID and RS phases.

Three specific hypotheses can be stated for the experiment.

1. Since it is assumed that rules learning will eliminate irrelevant response strategies, Ss given rules learning and pretraining should learn the initial discrimination more rapidly than Ss given pretraining alone.
2. Assuming that the effects of rules learning and pretraining are additive, Ss receiving both rules learning and pretraining should learn the initial discrimination more rapidly than Ss given rules learning alone.
3. Based upon Tighe and Tighe's (1968a, 1968b, 1969) consistent findings, Ss given pretraining alone should not differ in ID from control Ss who receive neither rules learning nor pretraining.

METHOD

Subjects

The Ss were 44 first- and second-grade children from the DeKalb, Illinois school system. Twenty-four boys and 20 girls, average age 7 years and 3 months, participated in the experiment. Data from an additional 33 children were gathered but not analyzed because of their failure to meet either the ID or RS learning criterion (25 and eight children, respectively). Each child was tested individually in a small research trailer adjacent to the

school.

Design

Each child was randomly assigned to one of four groups (see Table 1). Group E, the experimental group, received rules learning (RL) followed by pretraining, the ID phase and the RS phase. Group C_{RL}, a control for the effects of RL, received only pretraining followed by the ID and RS phases. Group C_p, a control for the effects of pretraining, received only RL followed by the ID and RS phases. Finally, Group C, a control for the combined effects of RL and pretraining, received only the ID and RS phases. In order to control for nonspecific learning effects, such as length of time spent in the trailer, play with jigsaw puzzles was substituted for the omitted phase(s) in each of the control groups. The experimental group consisted of 20 Ss and there were eight Ss in each of the three control groups.

Insert Table 1 here

Stimuli and Apparatus

The RL stimuli were three-dimensional, cardboard forms open at the bottom end varying in shape (circular base vs. square base) and orientation-of-line (horizontal vs. vertical stripes). Thus the four possible combinations of the two dimensions included a square, horizontally-striped cylinder, a square, vertically-striped cylinder, a circular, horizontally-striped cylinder, and a circular, vertically-striped cylinder.

The pretraining stimuli consisted of cardboard cylinders similar to those used by Tighe and Tighe and varying on three values of height (tall (T): 6", medium (M): 5", small (S): 4") and brightness (Black, Gray, White). Altogether, eight pretraining series were presented to each S, with each series consisting of a St stimulus cylinder and nine or ten Co stimulus

cylinders. The St stimulus was either a tall white (TW), small white (SW), tall black (TB), or small black (SB) cylinder for any one series. The Co stimulus cylinders for each series included the eight other stimuli formed from the nine possible combinations of the three height and brightness values, plus one or two stimuli identical to the St.

The stimulus cylinder pairs used in the ID and RS phases were the Sts used in pretraining. The pairings were either TS vs. SW or TW vs. SB. The RL, ID and RS stimulus pairs were presented using a modified WGTA. The pretraining stimuli in each series were presented simultaneously, rather than successively as Tighe and Tighe have done, because of the relative rapidity of simultaneous presentation shown in pilot study work.

Procedure

In the RL phase, Ss were instructed to pick up the stimulus cylinder in each pair that concealed a marble. For the Ss, the "game" was to find a marble each time a stimulus pair was presented. Each S was run to a criterion of nine-out-of-ten correct responses. Half of the Ss had shape as their relevant dimension and half had orientation-of-line, with the positive cue counterbalanced across Ss in each case. Also, the stimulus pairs were presented in a mixed order to minimize stimulus and position perseveration strategies. The order was the same for each S. Based on pilot work, each S was allowed a maximum of 40 trials in which to learn the RL phase. Any S not meeting the criterion within the 40 trials was returned to the classroom.

For the pretraining phase, the E initially showed the S the St stimulus in each series, and then pointed to each Co stimulus and asked S to judge if it was the "same as" or "different from" the St. The S's responses were not corrected or reinforced by the E, and all Ss received the same eight series in the same order.

The instructions and general procedure for the ID and RS phases were identical to those of the RL phase, with the important difference being the different dimensions employed. Half the Ss had height as the relevant dimension and half had brightness. As in the RL phase, the stimulus pairs for the ID and RS phases were presented in mixed order to minimize stimulus and position perseveration strategies. The nine-out-of-ten learning criterion was used in both phases. Pilot work suggested that the young S's attention spans for the entire experimental session was about 30 minutes. Therefore, each S was allowed a maximum of 75 trials in which to learn both the ID and RS phases. Any S unable to complete both phases within the 75 trials was returned to the classroom.

RESULTS

Analyses of variance were computed for the trials-to-criterion scores for the RL, ID, and RS phases. Because a relatively large number of subjects were unable to meet the ID criterion, the relationship between those Ss not meeting the ID criterion and their prior exposure or nonexposure to RL was also analyzed.

Analysis of the RL Phase

A 2 (Group) x 2 (Relevant Dimension) x 2 (Positive Cue) analysis of variance was initially performed on the trials-to-criterion scores in the RL phase for groups E and C_p. This analysis was performed to test for possible RL differences which could, in turn, affect later learning. The only significant effect produced by the analysis was a Group x Relevant Dimension interaction ($F = 7.84$, $df = 1,20$, $p < .05$). Further analysis of this interaction resulted in two significant effects. First, Ss in the E group met the RL criterion significantly faster than Ss in the C_p group when orientation-of-line served as the relevant dimension ($t = 2.88$, $df = 12$, $p < .05$).

Second, Ss in the C_p group met the RL criterion significantly faster with shape as the relevant dimension rather than orientation-of-line ($t = 2.51$, $df = 6$, $p < .05$).

Analysis of the ID Phase

Because of the relevant dimension and positive cue differences found in RL, a preliminary analysis of the ID criterion scores was performed as a function of the relevant dimension or positive cue used in RL. The results of the analysis proved to be nonsignificant for both of the factors. Thus, the RL data were collapsed across these two factors for purposes of the main analysis.

The mean trials-to-criterion scores and standard deviations for the ID and RS phases are shown in Table 2. Due to the heterogeneity of variance between groups, the scores were transformed prior to analysis using a $\sqrt{X + .5}$ formula previously utilized by Tighe and Tighe (1968a, 1968b, 1969). A 4 (Group) x 2 (Relevant Dimension) x 2 (Positive Cue) analysis of variance was performed on the transformed scores for both the ID and RS phases. Results of the ID analysis showed significant main effects for both Group and Relevant Dimension (both $p < .01$).

Insert Table 2 here

Further analysis of the main effect of Groups showed several significant effects. Group E learned the ID phase faster than both group C_{RL}, which did not receive RL ($t = 2.68$, $df = 26$, $p < .05$), and group C, which did not receive either RL or pretraining ($t = 2.11$, $df = 26$, $p < .05$). Group C_p, which received RL but no pretraining, also learned the ID phase faster than the C_{RL} and C groups ($t = 3.18$, $df = 14$, $p < .01$, and $t = 2.70$, $df = 14$, $p < .05$, respectively). Thus, Ss given RL (groups E and C_p) learned the ID

phase significantly faster than Ss (groups C_{RL} and C) not given RL ($F = 7.91$, $df = 3,28$, $p < .01$). The lack of performance differences between Ss given RL (group C_p) and Ss given RL plus pretraining ($t = 1.11$, $df = 26$, $p > .20$) indicates that the ID scores were facilitated by RL alone, with no significant facilitation due to pretraining. The failure of pretraining to facilitate ID scores is also indicated by the lack of difference between Ss given only pretraining (group C_{RL}) and controls (group C) ($t = 0.47$, $df = 14$, $p > .60$).

The facilitory effect of RL on ID scores was also supported by an analysis of the number of Ss in each of the four groups who failed to meet the ID criterion. The number of Ss who failed to meet the ID criterion in groups E, C_p, C_{RL}, and C were five, zero, thirteen, and seven, respectively. A Chi-square analysis indicated a significant difference among the four groups on rate of S attrition ($X^2 = 13.88$, $df = 3$, $p < .01$). Further examination of these group differences showed several significant effects. First, significantly fewer Ss failed to meet the ID criterion in groups where RL was provided (groups C_{RL} and C) ($X^2 = 9.00$, $df = 1$, $p < .01$). Second, for group C_p, the condition receiving RL but no pretraining, the S attrition rate was significantly less than that of group E ($X^2 = 5.00$, $df = 1$, $p < .05$), group C_{RL} ($X^2 = 13.00$, $df = 1$, $p < .001$), and group C ($X^2 = 7.00$, $df = 1$, $p < .01$). Thus, the group receiving RL alone appears to be the most facilitory condition with respect to ID learning.

With regard to the main effect of Relevant Dimension for the ID phase, Ss in all groups learned faster when height was the relevant dimension rather than brightness ($F = 6.42$, $df = 1,28$, $p < .01$). This finding is in agreement with that of Tighe and Tighe (1969).

The facilitory effect of height as the relevant dimension during ID learning was also supported by inspection of the number of Ss not meeting

the ID criterion as a function of the type of relevant dimension employed during the phase. A majority of the Ss (24 out of 25) not meeting the ID criterion had brightness as their relevant dimension rather than height.

Analysis of the RS Phase

Analysis of the RS phase produced no significant main effects or interactions. The fact that neither RL, pretraining, nor both significantly affected the speed of learning the RS phase ($F = 1.40$, $df = 3,28$, $p > .20$) is counter to the present author's hypothesis that pretraining following RL should facilitate RS, and is contradictory to Tighe and Tighe's consistent findings (1968a, 1968b, 1969) that pretraining alone facilitates RS learning.

DISCUSSION

In the present experiment, the purpose of introducing a RL phase prior to pretraining was to eliminate nonspecific response strategies, such as positional or sequential strategies, during the ID and RS testing phases. The function of the RL phase was to teach the Ss the "rules of the game," namely, to look for and respond to a specific dimensional-value/reward relationship. The following predictions were made with respect to the ID phase: (1) emphasizing the assumption that RL should eliminate irrelevant response strategies, it was predicted that Ss given RL plus pretraining (group E) should learn the ID phase more rapidly than Ss not given RL but receiving pretraining (group C_{RL}); (2) assuming that the effects of RL and pretraining are additive, it was hypothesized that Ss receiving both RL and pretraining (group E) should learn the ID phase more rapidly than Ss just given RL (group C_p); and (3) based on Tighe and Tighe's (1968a, 1968b, 1969) consistent findings, Ss given pretraining alone (group C_{RL}) should not differ from controls given neither RL nor pretraining (group C).

The results provide support for the first prediction. Subjects given RL plus pretraining (group E) learned the ID phase more rapidly than Ss not given RL but receiving pretraining (group C_{RL}). The results are also consistent with the third prediction. In agreement with Tighe and Tighe (1968a, 1968b, 1969), Ss given pretraining alone (group C_{RL}) did not differ from controls given neither RL nor pretraining (group C). The second prediction, however, was not supported by the results. That is, although the effects of RL and pretraining were assumed to be additive, Ss receiving both RL and pretraining (group E) did not learn the ID phase more rapidly than Ss given only RL (group C_p).

In general, the results of the present study show that Ss given RL (groups E and C_p) learn the ID phase significantly faster than Ss not given RL (groups C_{RL} and C). Although pretraining would be assumed to have a facilitory effect on ID learning following the positive effects of RL (Tighe and Tighe, 1969), such a pretraining effect on ID learning was not found in the present study. Instead, the results indicate that any facilitation of ID learning is due to the positive effects of RL alone. This is shown by the improved performance of groups E and C_p over that of groups C_{RL} and C, coupled with the lack of any performance differences between groups E and C_p, which differed only in the presence or absence of pretraining.

There are some strong similarities between the effect of RL on ID learning found in the present study and the learning-set literature on discrimination learning in children. First, the kinds of factors assumed to be contributing to the improvement in performance in learning-set problems (e.g., Harlow, 1959) and the present study are basically the same. Both involve elimination of stimulus preferences and response biases, and the development of appropriate observing responses and subsequent responding

based on attention to relevant cues. Second, both learning-set problems and the improvement in performance in the present study exhibit what appears to be an all-or-none process of development, rather than a slow, incremental process. (In the present study, the all-or-none process can be seen in the actual raw data, and is also reflected in the high variability of the group means (see Table 2)). Finally, a review by Reese (1963) of the learning-set literature dealing with young children's performance on discrimination problems shows that Ss, who learn the first problem to criterion, apparently have acquired the learning-set, and further training on other problems produces little improvement in performance. In a similar fashion, Ss who met the RL criterion in the present study, learned the ID phase usually in a very few number of trials, relative to those Ss not receiving RL.

In the present study, the failure to find a facilitory effect of pretraining on ID learning following the positive transfer effects of RL is contrary to the predictions of the present author and Tighe and Tighe (1969). It was hypothesized that RL would function to reduce or eliminate nonspecific response strategies which were assumed to be masking the effects of pretraining on ID learning. The data indicate that nonspecific response strategies were reduced or eliminated by RL, yet no pretraining effect was found. A potential explanation for the failure of pretraining to facilitate ID learning following RL involves the possible ineffectiveness of pretraining, per se, in the present study. There are two indications that pretraining failed to have its predicted effect, i.e., the equivalent abstraction of both dimensions. First, as stated in the results section, all Ss learned the ID phase faster when height was the relevant dimension, and 24 out of 25 Ss who did not meet the ID criterion had brightness as their relevant dimension rather than height. These data suggest a strong S preference for

height as the more salient dimension.

Second, casual observation during pretraining suggests that Ss preferred the height over the brightness dimension, since many of the Ss' "same" matchings during pretraining appeared to be made on the basis of height alone with little regard for brightness differences between the St and Co stimuli. This observational evidence is substantiated by a Silleroy and Johnson (1973) study showing that perceptual pretraining does not affect the dimensional preferences of five- or eight-year olds. Thus, again it is possible that pretraining had an unequal effect on the children in abstracting the two dimensions for subsequent use in the ID phase.

This apparent ineffectiveness of pretraining may be due to differences in stimulus values and method of presentation between the present study and those of Tighe and Tighe (1968a, 1968b, 1969). In order to simplify construction of the pretraining stimuli, the present study employed height values of 4", 5", and 6". Tighe and Tighe have consistently used values of 4-3/4", 5-1/2", and 6-1/4". The slightly increased range of values in the present study may have emphasized the salience of the height dimension at the expense of the brightness dimension during pretraining. (However, it should be noted that the brightness dimension range was also quite large.)

Although Tighe and Tighe (1968b) did not find the method of pretraining-stimulus presentation to be an important variable, they have typically used the successive method. The present study used the simultaneous method because of its relatively rapid speed of presentation. This simultaneous method of pretraining may, in fact, be less effective, since the successive method used by Tighe and Tighe more closely approximates the ID and RS phases, which require integration of information over trials in order to detect the dimension-value/reward relationship. Thus, using slightly

different pretraining stimulus values and method of presentation may help to account for the lack of a pretraining effect on ID learning in the present study.

The apparent ineffectiveness of pretraining in the present study may also help explain the lack of a significant pretraining effect on RS learning, which is contrary to Tighe and Tighe's (1968a, 1968b, 1969) findings. An explanation of the lack of significant pretraining and RL effects on RS learning concerns the relatively large number of Ss who were unable to meet either the ID or RS criterion (25 and eight, respectively) and were subsequently dropped prior to analysis. This relatively high rate of attrition may, in turn, have produced an unforeseen sampling bias. Specifically, a "floor" effect may be operating to eliminate any chances of obtaining significant learning-rate differences between groups in the RS phase. This is suggested by the very rapid RS learning demonstrated by Ss in all the groups.

A replication of the present study is currently being considered. Such a replication would incorporate the following methodological changes: (1) extending the total number of trials in the ID and RS phases in order to reduce the relatively large S attrition rate; (2) using stimulus height values that are identical to those used by Tighe and Tighe, or using dimensions that are completely new, but equally salient; and (3) designing and incorporating some means of successive presentation of the pretraining stimuli that minimizes the between-presentation interval, and thus avoids subject fatigue across the total testing session.

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TABLE 1

Activities of the Four Groups in Each of the Four Phases of the Experiment

Group	Phase			
	First	Second	Third	Fourth
E	Rules Learning	Pretraining	Initial Discrimination	Reversal Shift
C_{RL}	jigsaw puzzle play[a]	Pretraining	Initial Discrimination	Reversal Shift
C_{P}	Rules Learning	jigsaw puzzle play	Initial Discrimination	Reversal Shift
C	jigsaw puzzle play	jigsaw puzzle play	Initial Discrimination	Reversal Shift

[a]The unrelated jigsaw puzzle play was used to control for any nonspecific learning effects.

TABLE 2

Mean Numbers of Trials-to-Criterion[a]

in the ID and RS Phases

Groups	ID Phase Means (Standard deviations in parentheses)	RS Phase Means (Standard deviations in parentheses)
E	7.35 (15.22)	2.3 (3.31)
C_P	1.00 (2.83)	4.75 (5.85)
C_{RL}	22.63 (11.72)	6.38 (6.46)
C	19.38 (18.05)	4.38 (3.66)

[a]Values represent the last trial prior to the criterion block of ten trials.

FOOTNOTES

1. Author's master's thesis presented at the Midwestern Psychological Association convention in Chicago on May 2, 1974.
2. The first author is greatly indebted to Dr. Miller, the thesis director, for her guidance and encouragement throughout the course of the research.

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